CULTIVATING (IN) TROPICAL FORESTS? THE EVOLUTION AND SUSTAINABILITY OF SYSTEMS OF MANAGEMENT BETWEEN EXTRACTIVISM AND PLANTATIONS

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ABSTRACT

Rural households throughout the tropics have developed a wide range of systems for the management of forest resources. An interesting and valuable class of systems is those that are intermediate on the continuum from pure extraction to plantation management. Such "intermediate systems" (IS) range from natural forests modified by managers for increased production of selected products through to anthropogenic forests with a high density of valuable species within a relatively diverse and complex structure. IS offer important subsistence and cash incomes, as well as attractive strategies for capital accumulation, risk spreading, and labour reduction. They can also help to secure tenure rights and yield significant biodiversity benefits at both local and global levels.

Despite these important contributions of IS to maintaining functioning of both the human and ecological systems in the tropics, IS have been largely overlooked by the development community. This is party because IS fall outside of the dominant agriculture/forestry divide paradigm, but also because of the absence of a recognized conceptual framework. This paper contributes to the development of such a framework by identifying some common features of IS, summarizing their key social, economic and environmental advantages and constraints, and examining the trends and driving forces that lead to their development, persistence and, in some cases, decline. We identify the conditions under which such systems can be important and conclude with a discussion of policy implications.

1 "INTERMEDIATE SYSTEMS"?

The past two decades have seen a resurgence of interest in the many products and services of forests. The age of colonial exploration was fueled, in part, by the search for new products from the tropics, many of which are now labeled "non-timber forest products" (NTFPs). Tropical forests were then valued for their non-wood resources as much as for their timber. That interest in NTFPs peaked before WWI with the development of industries based on natural products such as latex and resins. Interest then languished post WWII as ideas of industrialization and mass production dominated, not least in agriculture and forestry. Forest management became more or less exclusively a tool of the wood industries. But then, beginning in the early 1980s, in conjunction with the "sustainable development" movement, an increased recognition emerged of the actual and potential value of forests to provide many different products and services. Once again interest in NTFPs surged, but this time the focus was on using them as tools to achieve simultaneously forest conservation and poverty alleviation. The new interest in NTFPs tended to focus on the collection of products from the wild. The term "extractivism" was coined, first in Latin America, to describe this kind of forest use. It implied, sometimes correctly and sometimes not, that people simply went to the forest to take what they needed as a kind of "subsidy from nature". At the same time, as certain products attained high value, there was pressure to cultivate and manage them more intensively. This divide between extractivism and cultivation of NTFPs reflected the important dichotomy that characterizes forest management more generally, namely between *natural forest management*, which refers to the use of wild resources in natural ecosystems, and *plantation forestry,* referring to specialized and intensively managed resources.

While international interest waxed and waned and waxed again, forest people continued to manage, use and trade a wide range of products. The reality of local forest management is much more varied than the extractivism/cultivation divide suggests, with a continuum of production systems between the two extremes. Various intermediate systems (IS) have been described, both contemporary and historical, that involve management of naturally occurring forest species, enrichment planting and fostering of valuable species in natural forests, or incorporation of forest species into agricultural production systems. Models developed by small-scale (often indigenous) forest managers range from light management of a particular resource/species in a native ecosystem to the total replacement of the original forest by forest-gardens, agroforests or plantations.

IS represent a large zone on the continuum of management possibilities between pure extraction and intensive monoculture plantations. Unlike pure extraction systems where products are gathered from the wild, intermediate systems are deliberately managed for the production of (predominantly) forest products. They use lower inputs per unit of land than pure plantations. The production unit is typically a diverse ecosystem that maintains many economic as well as ecological functions, unlike specialized tree plantations. "Intermediate" therefore refers to two key and related aspects, namely the intensity of inputs and the ecosystem structure and function. It does not necessarily imply a temporal evolution, though whether or not such systems are in transition toward more intensive management is an important question explored more fully later.

In practice, many of these intermediate management models are used by smallholder farmers, outside natural forests, in complex forest gardens within predominantly agricultural landscapes. And yet, for a number of reasons, this seemingly promising and rich set of management models has been largely overlooked by development practitioners and policy makers.

There are two opposing sets of arguments concerning the potential and value of IS. Some question the economic and/or ecological sustainability or profitability of these systems, arguing that they are just stages of “primitive horticulture” in a transition from hunting/gathering to modern agriculture or silviculture (Sauer 1952, Harris 1972, Purseglove 1974, Homma 1992). This perception has resulted in a lack of official acknowledgement and inadequate technical support for these intermediate systems.

Others argue that IS are able to meet economic, ecological and social objectives better than either extractive systems or specialized intensive systems (Padoch & Peters 1993, Michon & de Foresta 1999). In particular, they provide a good compromise between biodiversity and productivity considerations (van Noordwijk *et al.* 1997). They also fit well as an integral part of the overall household economy. Proponents argue that such systems can be more than just transitional stages, and may be viable over long periods of time. If so, there is a strong rationale for investment and policy interventions to protect existing IS and to promote the expansion of the model.

The Lofoten workshop grew out of a recognition that IS developed throughout the tropics share a number of common features, can play an important role in resource management and socio-economic development, and have potential for wider application. IS may, for example, fit well with buffer zone management schemes around protected areas, or with other integrated conservation and development projects. They might also represent the “best bet” for perennial crop production in smallholder production systems, especially in areas where natural conditions limit the development of intensive cropping of annuals. Our goal is to critically examine the different positions in this debate. We focus on two closely related aspects, the driving forces and evolution of IS over time, and their stability and sustainability. These two aspects provide a unifying theme throughout this concept paper, and are also addressed by many of the abstracts that follow.

This paper will introduce IS as a concept and explore some of the key issues and questions surrounding IS. The paper begins, in section 2, with a few examples of intermediate systems to set the stage for the discussion that follows. These and several other systems were discussed and analyzed in detail during the workshop. Based on this presentation, we summarize some of the common elements of IS. In section 3 we discuss important benefits of this class of management system. The role of IS in household economies, their technical requirements, and their importance in social strategies, ecological structure and functioning, and national economies are examined. We then examine the question of “dynamics” in section 4, considering the development trends and key driving forces that influence the emergence and evolution of IS. How and why do these systems emerge, persist, and decline? Within this discussion we provide an overview of several theories and frameworks that conceptualize the development from extraction to intensive production in agriculture and forestry, with an effort to identify weaknesses/failings in the current understanding of IS. Finally, in the last section, the key question is whether, and under what conditions, these systems can be viable. We then step back and summarize the discussion, before concluding with a brief consideration of some policy and research implications.

2 INTERMEDIATE FOREST MANAGEMENT SYSTEMS – AN OVERVIEW AND A FEW EXAMPLES

2.1 THE RANGE OF OPTIONS

There are numerous contemporary examples of intermediate systems. Some of them are centuries old practices, like the *miang* tea system in Thailand and China, and the benzoin gardens and cinnamon gardens of western Indonesia. Others have been developed more recently: rubber and damar gardens at the turn of the 20th century; cardamom cultivation in Laos a few decades ago. They span a range of approaches from the intensified production of one or more products within a natural forest through to anthropogenic forests maintained or restored on (formerly) agricultural lands (see Michon & de Foresta 1999, and Wiersum, this volume). Here we give a brief account of some examples that were discussed in detail during the workshop.

2.2 MODIFIED NATURAL FORESTS

The most basic form of management beyond pure extraction is to modify the environment to favour the production of a valuable product. This might involve weeding around valued species, opening the canopy for light-demanding species, or encouraging shade plants for shade-demanding species. The fostered plants might be self-sown or they might be deliberately planted, from seeds, seedling, or wildlings moved to preferred locations. The *miang* tea production (described by Watanabe *et al.* 1990) provides a good illustration. The system is practiced from Northern Thailand to Southern China, with a range of traditional practices. The least intensive approach is to clear some of the forest vegetation around wild tea bushes to reduce competition for water, nutrients and light, and so increase their natural production. These gardens usually have a low density of tea. More intensive practices involve planting of seedlings raised in nurseries, or transplanting of wild saplings, to locations in the forest where the undergrowth has been cleared, with canopy trees retained to maintain regular shade. These gardens can be maintained for over a century, with replanting of senescent trees if needed. Tea trees are only lightly pruned, compared to commercial tea-estate practices. The system is evolving towards more open tea gardens, such that the most "intensive" tea gardens have few of the original tree species left. Practices of this kind have also been well documented in the Amazon region, with the management of cultivated stands of *Euterpe* palms—for palm heart and juice production—in swamp forests (Anderson 1987; see Box 1), or of Brazil nuts (Balée 1989; see Box 2), while in Southeast Asia, cardamom cultivation in Laos provides another example of modified natural forests (see Box 3).

Box 1: Açaí palm in the estuary of the Amazon river (by Susan Mogenburg)

Açaí palms (*Euterpe oleracea*) are estimated to dominate forest canopies in ca. 10,000km^2 of floodplain forest in the Amazon River estuary, Brazil. Acaí is the source of two economically important non-timber products: palmito or heart of palm, and fruit, which is made into a beverage that is a staple in the regional diet. The strong, international palmito market is valued at $US13 million, while the growing, regional açaí fruit market is worth approximately $US20.3 million. Açaí is a favored forest species for producers because the two products complement each other seasonally. The prevalence of açaí management in the estuary emerged in the 1960's, when markets for both products grew due to depletion of other palmito sources and growing urban fruit markets. Forests managed for açaí begin as either abandoned agricultural fields or as non-managed forests. Management involves planting and relocating açaí seeds and seedlings, weeding, thinning, and girdling other species, and maintaining optimal densities of palms. This management results in forests that appear ecologically intact, but which differ greatly from non-managed forest. Specifically, managed forests have significantly more palms and fewer stems of hardwood trees, vines, and lianas than do non-managed forests, which also have a higher, more closed canopy and greater overall stem densities and basal area. Furthermore, açaí managed forests support a significantly different bird community than do non-managed forests. Due to these ecological impacts, açaí management should be only one part of a landscape management strategy for the Amazon estuary that includes improved incomes for estuary inhabitants.

Box 2: Brazil nut (by: Adrienne Henkemans)

In the northern Bolivian Amazon the Brazil nut tree (*Betholletia excelsa*) performs itself as a backbone species of a complex agro-extractive forest management system. It is a tropical evergreen tree species endemic to the forests of the Amazon river basin of South America, usually growing at an abundance of only a couple of trees per hectare. It is an emergent tree that reaches a height of about 50m, forming an upper canopy component of the terra firma forest. The species naturally propagates by the production of large fruits in the form of spherical woody pods that contain 10-25 Brazil nuts and ripen and fall between November and March. Amerindian forest dwellers as well as multi-ethnic colonists collect the nuts for subsistence purposes and for income generation. They manage the trees in primary forest stands, protecting and promoting the trees in their developed agroecosystems, a practice that in some areas has resulted in clusters of 15-20 mature trees per hectare. For the Amazonian forest dwellers the Brazil nuts are an important additive to their diet, containing high amounts of digestible fats and proteins. The bulk of the nut harvest, however, is sold on national and international markets, contributing to the economic livelihood of the collectors and other entrepreneurs involved. World-wide the nuts are consumed raw, roasted or processed into sweets, oil, soap and other cosmetics. Other parts of the tree such as the bark, wood and leaves are used locally for medicine, fuel, timber, tools and handicrafts. About half of the 12,500 urban and rural Brazil nut collectors are independent forest dwellers who, on average, depend on the nuts collected from their family forest plots for more than one-third of their income. The owners of the forest plots take care not to damage the Brazil nut tree and its habitat with slash and burn activities by establishing their agricultural fields in areas without such trees. In order to increase the amount of the harvest and facilitate collection of the nuts, they remove the undergrowth of the trees as well as lianas that climb the tree. Thus, the Brazil nut tree is part of an agro-extractive system that relies on the maintenance of a primary forest cover and a large diversity of species.

Box 3: Cardamom gardens in Southern Lao PDR (by Joost Foppes)

Cardamom (*Amomum villosum*) is the second largest agricultural export from Lao PDR. Every year 400-500 tons of dried seeds are exported to China, where it is used in as an ingredient in Chinese medicine, known as "sha ren". Roughly 70% of cardamom produced in Lao PDR comes from the wild, 30% from cultivated gardens. Export price has been stable around US$ 7 per kg dry seed over 5 years. Cardamom cultivation is wide spread in the districts of Bachiang, Pak Xong and Laongam in Southern Laos. These gardens are not real plantations in the strict sense, as they are established in clearings in the forest where wild forest cardamom is allowed to regenerate after a year of growing upland rice. By weeding and other cultivation measures such as pruning larger trees and clearing climbers, farmers achieve an almost pure stand of cardamom. Cardamom remains the dominant ground cover for a period of 20-40 years, while the secondary forest grows back over it with time. In the village of Ban Kouangsi, 200 families have cardamom gardens. Due to the hilly terrain, it is difficult to grow paddy rice. Two thirds of these families cannot produce sufficient rice and have to buy rice to feed the family all year round. Cardamom sales make up 35% of gross crop income per family and 87% of the cash requirement to buy rice. Other major cash income sources were groundnuts and livestock sales. All cardamom gardens are owned by someone, as there is no "open access". The best cardamom is said to be from 3-4 year old fields; however most fields are 20-30 years old, while the oldest field was 60 years old. These gardens continue to produce over an indefinite period of time, as long as the gardens are maintained properly. Maintenance is done once a year, at the same time as the harvesting. Cardamom needs some shade. Harvesting of cardamom usually takes place in October. The average yield is 120 kg/ha dry seed. An average family of 5-6 persons has 1-2 ha of cardamom gardens.

2.3 FOREST GARDENS WITHIN THE FOREST MATRIX

More intensive systems involve greater and longer-term interaction between human production efforts and natural forest cycles. Whereas most examples are closely integrated with agricultural systems (see next section), some are purposefully integrated and maintained within forest stands. A good example of this kind of integration is the benzoin cultivation system practiced in North Sumatra, Indonesia (see descriptions by Garcia, Katz, Michon, this volume). Benzoin is a medium-sized tree that occurs naturally in the undergrowth of lowland and montane forests of South-East Asia. It produces a fragrant resin used as an ingredient in incense and perfumes. In the benzoin cultivation system developed by *Batak Toba* people in North Sumatra, benzoin trees are first planted in the undergrowth of a patch of natural montane forest. Canopy trees and undergrowth species are then selectively cut as the benzoin trees develop to maintain a micro-environment with high light and low temperature. High-quality hardwood species and pines in the canopy are favored while others are removed, leading initially to a relatively low diversity of mature trees. The undergrowth retains many shrubs and epiphytes typical of the surrounding montane forest. As long as benzoin trees are tapped for resin – beginning as early as year 10 and continuing for up to 35 years - the garden is maintained and its structure remains somewhat open. Management is gradually reduced, with less and less control over the self-established tree species, and the garden is abandoned after a maximum of 65 years. This gradual relaxation of maintenance practices allows the garden to revert to a natural forest structure. After several decades, the resulting "pristine" montane forest can be used again for benzoin production if needed. Another example of a forest garden system that may be established within the forest matrix is the collection of paper bark from particular forest tree species for handicrafts production in Mexico (see Box 4).

Box 4: Paper bark in Mexico (by: Citlali Lopez)

One of the most commercialized handicrafts in Mexico is hand-made bark paper, traditionally manufactured by the Otomi, an indigenous people living in central eastern Mexico. A growing number of temporal harvesters from an extended area are involved in bark extraction as bark paper demand has increased in recent years. Further, a growing number of tree species have been adopted as raw material. Six of the bark-tree species belonging to the genus *Ficus* are used since ancient times by the Otomi for ritual paper manufacturing. An additional seven tree species belonging to different genera have been adopted during the last 30 years. These trees usually occur as scattered individuals or in dense aggregations in gallery forests, forest patches, fallow lands, homegardens and shaded coffee plantations. Among them, the most intensive extraction occurs from *Trema micrantha,* a tropical pioneer tree species commonly growing in shaded coffee plantations. As part of coffee plantation management *T. micrantha* are removed after four to six years old to avoid plant competitiveness and tree shade excess. At present these trees are completely debarked by temporal harvesters. Bark paper manufacturing is largely depending on shaded coffee plantations, which at a regional level represent important niches for nature conservation due to their high biodiversity and constitute important key multiple purpose land use systems for small-scale farmers.

2.4 ANTHROPOGENIC FORESTS FROM AGRICULTURAL ANTECEDENTS: ROTATIONAL SYSTEMS

Most existing examples of IS are closely integrated with agricultural systems. Examples of anthropogenic forests in agricultural lands range from rotational forest cultivation systems that are integral parts of a shifting cultivation system through to permanent forest-gardens. Unlike the examples above, in these systems the original forest ecosystem is more-or-less completely removed and a new forest is generated for specific production purposes. South-East Asia has a particularly good representation of these systems.

For example, rattan is cultivated as part of traditional swidden cultivation systems in Indonesia (first described by Weinstock 1983, see also Fried 2000, and in this volume descriptions by Angelsen *et al.*, Belcher *et al.*, Garcia *et al.*, Michon), and in south-western China (Pei *et al.* 1994). The rattan is planted along with, or subsequent to, rice and other annual crops, and allowed to grow in the regenerating forest during the fallow period. Rattan canes can be harvested beginning 8 to 12 years after planting (or earlier, depending on species and local conditions). The commonly cultivated rattan species grow in clumps and harvest of individual stems does not kill the plant. The rattan garden can yield canes for the following 20 to 50 years, which is usually accompanied by a notable enrichment of garden plots with fruit trees. Rattan “gardens” resemble a naturally regenerated secondary forest except that they have a higher density of rattan (and often other valuable species as well). Productive gardens may be managed for 50 or more years, or recycled in the swidden cycle after two or three “crops”—3 to 6 years after the first harvest—for a new rice-and-rattan cycle.

Rubber gardens in the lowlands of Sumatra and Kalimantan provide another example of rotational forest production (see Laxman *et al.*, Danielsen *et al.*, this volume). Though the cultivated rubber tree is not a native species, swidden cultivators in Sumatra and Borneo adopted it into their swidden production system not long after its introduction in the colonial estates in the late 19th century (Pelzer 1945; Dove 1993; Gouyon *et al.* 1993). Rubber trees, sown in a rice swidden and growing in a secondary (fallow) forest can be tapped after 8 to 10 years. The normal cycle for this small-holder rubber production is of 35 to 40 years, but some rubber gardens are managed over a longer time, with gradual replacement of senescent trees by self-established rubber seedlings. After a maximum of 70-80 years yields decline significantly and the garden must be re-established.

Rubber gardens tend to be more permanent than the rattan gardens described above, and the tree density is higher. However, as with rattan gardens, their structure is similar to that of the typical successional vegetation and, even though rubber trees are exotics, rubber gardens are often confused with natural secondary forests. Due to their perennial nature, combined with management practices that leave a major role to natural processes, the rubber gardens have high biodiversity. This partially-managed richness provides many secondary products—plant-based foods, fibres, medicines and other products, timber, game meat—which compensates for the relative low productivity of the rubber. In addition to this economic importance for farmers, rubber gardens play a role in the conservation of plant and animal biodiversity in the lowlands. The importance of this role is increasing with the depletion of the last unlogged dipterocarps forest of this ecozone (Gouyon et al 1993).

2.5 ANTHROPOGENIC FORESTS FROM AGRICULTURAL ANTECEDENTS: PERMANENT FOREST CULTURE

Other examples of forest gardening practices in Indonesia have resulted in the establishment of domesticated forests with diversified economic functions, and with structures and species diversity approaching those of late-successional or old-growth forests. In the example of damar gardens (a resin-producing *dipterocarp*) in Sumatra (Michon *et al.* 2000), the plantation starts, as in the rattan system, with damar seedlings co-planted in the swidden field and developing with the fallow vegetation. Damar gardens are not tapped before 25 years, and there is a high level of recruitment of other species in the interim. In the mature garden, natural processes and appropriate management of individual trees helps maintain a system that produces and reproduces without disruption in structural or functional patterns. The garden becomes more diverse with the establishment of more climax forest species in the cultivated stage. After 40-50 years, the damar plantation reaches its peak production period.

From a socio-economic point of view it is not fundamentally different from a specialized commercial plantation. Damar resin provides the majority of household cash income and complements the rice-based farming system (Levang 1993, Michon *et al.* 2000). However, from a biological point of view, the mature phase resembles more the forest it replaced than a conventional tree plantation. The resulting forest is characterized by a high canopy, a dense undergrowth, high levels of biodiversity, and perennial structures.

Other examples of such permanent forest culture exist in Indonesia. In West and Central Sumatra farmers integrate the production of cinnamon with coffee or nutmeg below a high canopy of large trees cultivated for timber and fruit production (Michon *et al.* 1986; Aumeeruddy & Sansonnens 1994). The cinnamon stand is usually completely harvested after 8 to 12 years and then replanted. Some incremental harvesting can be done if needed. Self-established vegetation is usually conserved. However, due to the high density of the cinnamon stand, the main plant biodiversity is in epiphytes on the canopy trees, small lianas, and undergrowth herbs. Many types of fruit-based forest gardens are to be found throughout the Sumatra and Kalimantan lowlands (de Foresta *et al.* 1993; Salafsky 1994). Some of the better-documented systems are the highly-diverse fruit forests of East Kalimantan (Bompard, 1988; Seibert 1989, Sardjono, 1992) and the illipe-nut gardens in West Kalimantan (Momberg 1993; Padoch & Peters 1993; Sundawati 1993; de Jong 1994). In North Sulawesi and in Lombok, forest garden systems are centered around a sugar-producing palm (*Arenga pinnata*) and in the Moluccas coconut trees and tall nut-producing *Canarium* are integrated in the canopy layer with the Tahitian chestnut, nutmeg or clove, or a mixture of these, plus banana groves, in the lower levels (Michon & de Foresta 1999).

Outside Indonesia, coffee, cocoa, and many other commodities are sometimes integrated with other trees. Native oil palm groves in Congo (Michon 1987), mixed fruit tree gardens in southern Nigeria (Okigbo 1983) or cocoa growing in Cameroon, which has emerged as a mixed system (see Dounias, this volume), are good examples of African IS. It has been noted that even some intensive cocoa plantations in Cameroon are shifting away from monoculture toward a more mixed system (Ousseynou Ndoye, pers. com.).

2.6 COMMON ELEMENTS OF INTERMEDIATE SYSTEMS

Each of these systems has it's own particular features. They have been developed under different historical, economic, social and political contexts. The driving forces and the dynamics of their emergence, expansion or decline are also varied. However, beyond, the local particularities, they exhibit interesting universal features and qualities that, collectively, are distinct from either extractive systems or true plantation systems. Intermediate systems tend to exhibit the following characteristics: [1]

Commercially valuable main crop: all examples of IS are designed to produce at least one commercially valuable product, and this has been a major driver behind their evolution. In many cases this product represents the main or only source of cash income to producers.
Diversification of income sources: in almost all cases, people who manage forest products in IS also manage several other crops and economic activities. Typically they are smallholder farmers, with either permanent or shifting cultivation systems that incorporate one or several field crops. Also the forest garden may contain other valuable plants, fungi, and animals that are used for subsistence and sometimes for sale. If there are natural forests nearby, they may also harvest from them. One of the repeated messages of the workshop was that it is imperative to think of these as integrated systems and not as single-product production units in isolation.

Integration in farming systems: related to the previous characteristic, IS usually do not exist in isolation, but are part of local farming systems, in which they complement subsistence cropping of staples and other economic activities.

Risk spreading: managers of IS tend to be limited in their ability to accumulate capital and are therefore vulnerable to risk. The diversification of income sources and products produced in IS helps them to spread the risk.

[1] We recognize that some of these features are not unique to IS but apply generally to much of the tropical rural economy. Yet, they are important when distinguishing IS from particularly intensive monoculture and to some extent also extractivism.

Maximization of returns to labour: IS tend to be found in areas where labour is the limiting factor of production, while land is usually relatively abundant (though not necessarily of high quality). People make decisions based on how best to allocate their labour time, especially during peak periods.

Main crop has medium-term maturity and regular harvesting: typically, IS feature products that have a short- to medium-term time frame to harvesting maturity. Examples include cardamom and coffee (4 years), cocoa (5 years), rattan, benzoin, rubber or cinnamon (8 – 10 years). The single exception in our examples is damar, with 25 years to the first harvest. Most products can also be harvested recurrently, sometimes with multiple harvests through the year (rubber, tea leaves, damar, benzoin), annually (cocoa, coffee, cardamom, fruits), or at most every two to three years (rattan).

Diverse structure and multi-functionality: the land cover in intermediate systems tends to resemble natural secondary forest, with a relatively diverse structure. They perform many forest functions, both in terms of supply of forest products and ecological functions.

Clearly defined access and control systems: Property regimes associated to IS are usually defined by customary rules, even if these are rarely acknowledged in the national legal systems. Managers have rights of ownership and often sanctions exist to protect against theft. Indeed, in some cases, the product itself (e.g. rattan in Kalimantan) serves as a *property marker*.

A particular role in the shaping of social relations: the social –and often the socio-political-meaning of IS is an important part of their success. These include aspects related to social stratification and local power, gender balance, or relation with dominant political and economic structures. IS are also presented by their managers as an important aspect of their culture and identity.

These characteristics help to explain the particular roles and functions of these systems, discussed next, and point to key issues to help understand how and under what circumstances these systems have developed, where they are likely to be most stable and where they are no longer be the most appropriate management systems.

3 INTERMEDIATE SYSTEMS – RATIONALES, ROLE AND POTENTIAL

Although there has been research and recognition of individual IS, they have rarely been defined as such (see Michon & de Foresta 1999 for a conceptual approach to the study of agroforests). Due to the lack of a practical conceptual framework to facilitate analysis, understanding and comparison among these systems, these individual approaches have been largely overlooked by the scientific community, and even more by professional foresters and rural development specialists.

There are also other reasons for this lack of professional and scientific recognition of IS. Deeply rooted prejudices exist within the dominant theories of agricultural development. The rise of agriculture, with plant domestication and ecosystem simplification and specialization for crop production, is seen as one of the most significant steps towards the development of modern civilizations. Hunting and gathering and indigenous horticultural systems in the tropics are commonly considered to be primitive forms of resource management. These perceptions of what forest and agriculture are and should be have driven the imposition of western scientific principles over local resource management approaches in the tropics.

Specialized agricultural systems were mirrored in the tree plantation model that has been transferred to the tropics for timber and pulp production, and peasant models of integrated agriculture and forest utilization have been regarded, implicitly or explicitly, as inferior to modern approaches. Traditional IS have not only been disrespected, but more often they have not been recognized at all. It is easy for agronomists and foresters trained in western agriculture and forestry schools to be oblivious to native systems that appear wild and disordered compared to the neat rows of even-aged trees in a plantation. A perfect example is found in Indonesia, where the government classified rattan gardens as “degraded forests” and systematically scheduled such lands for conversion to large-scale plantations.

As a result of these factors IS have received little attention or support. The upside is that there is untapped potential. As the multiple values of forests are increasingly recognized – for goods and services beyond industrial timber and pulp – existing intermediate systems offer a model for multiple-use forest management. Before assessing the evolution and sustainability of such systems, we need to know more about these systems and place them in a wider context. The following discussion focuses on the apparent benefits of these systems, from their role in the household economy and in social strategies to their importance in national economies and for ecology/biodiversity conservation, comparing the advantages and constraints of these systems with extractive systems and specialized plantations.

3.1 ROLE IN HOUSEHOLD ECONOMY

Forest products produced in intermediate systems are typically only one of several components of the household economic portfolio. These systems are usually found associated with either permanent food production systems, shifting cultivation practices, or specialized plantation practices, and are often combined with off-farm activities. They usually are important in household cash income earning – as noted above, IS typically have at least one cash crop as the dominant product, and this may be the main or only source of cash income. For example, rubber contributes about 60% of the total income of the households in a system in Riau, Indonesia (Angelsen *et al.* this volume). In the benzoin case reported by Garcia *et al.*

(this volume), income from benzoin amounts to 14% of the total income for the whole sample, and 30% for those harvesting benzoin (Angelsen *et al.* this volume).

In addition to the main commercial product, these forest gardens also contain other resources that can be harvested for either regular domestic purposes (food, fodder, fiber) or for special needs (medicinal products, ritual products or urgent cash sales). The diversity of income forms and rhythms is essential in areas where capital accumulation is difficult, where habits of saving are not well developed and where credit is expensive or unavailable; that is to say, in rural areas throughout the developing world.

Forest gardens incorporate numerous other economic functions that help diversify the farmer's income and reinforce economic stability, effectively spreading risk. Intermediate systems also allow people to retain "option values" - they can keep a range of economic choices open for the future, a critical consideration in the rapidly changing socio-economic environments in which many forest-based people now find themselves. Diversified IS also contain other potential resources, offering the possibility of switching from existing commodities to more profitable ones if and when the market changes. Alternatively, new economic tree crops could be integrated in such systems without disrupting the overall structure of the production system. IS can also generate valuable inputs - material, fertilizers, genetic resources, capital - for other components of the overall system (see Box 5).

Box 5. Intermediate Systems of Tree-Crop Integration in the Hills of Nepal (by: Ramji Neupane)

In the Nepalese hills, forest and crop biomass flow into cropland in the form of organic manure, mulch, animal feed and bedding materials for livestock, accounting for a considerable proportion of nutrient supply to crops. Population growth combined with land fragmentation, large livestock herd size, deforestation and heavy extraction of natural resources have put enormous pressure on farmland and are causing hardships to farming communities. In particular, erosion rates of 8-12 tons ha^{-1} $year^{-1}$ from hills threaten the sustainability of farm production. Perennial trees act as surface mulch that replenishes nutrients, conserve soil moisture and improve soil OM content. Nepal Agroforestry Foundation (NAF), a NGO, initiated an agroforestry project in Dhading district, Nepal in 1993/94 to promote the integration of perennial trees (e.g., *Leucaena leucocephala* and *L. diversifolia*, *Calliandra calothyrsus*, *Flemingia congesta*, *Morus alba* and *Gauxuma ulmiformis)* within agricultural fields. Results indicate that the project households had planted higher number of species than non-project households. Though project plots contained relatively higher amount of OM and N than non-project plots, the differences were not significant due to slow effect of trees on soil fertility and massive nutrient removal through intensive fodder, fuelwood and poles extraction. The benefit cost ratio of improved system (2.5) was higher than conventional system (1.8), and increased further to 2.9 when multipurpose species (mulberry) was introduced and used for sericulture. Multiple factors, including farm size, land ownership, livestock number, education, membership in local institutions, perception and extension, were shown to influence farmers' decisions to adopt new practices. In particular, livestock population and male membership in a local NGO showed consistent positive and significant effects on adoption by both project and non-project households. These results suggest that integration of trees on farmland represents an intermediate level of evolution towards intensification and loose integration into the commercial strategies of small farmers in the hills. Positive perceptions, access to technology and markets, improved education and better support services would help to increase the adoption of intermediate systems.

Intermediate systems also offer opportunities for capital accumulation, something normally very difficult for smallholder farmers or shifting cultivators. Despite relatively high labour productivity, smallholder agriculture and shifting cultivation systems do not generate significant surpluses. Forest products produced in intermediate systems generate additional income (cash and direct-consumption) at low cost. Enriching the forest or planting trees in the swidden can be done with low labour inputs and provide surpluses that can be saved or converted into "luxury" consumption (often children's education). It also creates assets that will increase the production capacity of the farm and that can be transferred to the next generation.

3.2 TECHNICAL QUALITIES

IS are characterized by intermediate levels of energy, capital or labor inputs, and the use of simple and relatively low-cost indigenous technologies. The technical simplicity is complemented by the full utilization of natural biological and ecological processes that are vital for both commodity production and reproduction, which implies a strong environmental knowledge base, especially of forest dynamics (Aumeeruddy 1994, Momberg 1993). Fertility is maintained over years by natural nutrient cycling processes, necessary inputs are generated by the system itself, and regeneration relies on natural processes. Thus, intermediate systems both conserve and utilize forest resources and structures (Michon et de Foresta 1999).

The simplicity and the relatively low costs of the techniques involved contrast sharply with conventional plantation forestry (or perennial crop plantations) which depends heavily on specialized technical knowledge, on high-yielding (and often genetically homogenous) planting material, and on capital and energy intensive processes of crop establishment and maintenance. Tree growing within IS, on the other hand, has multiple products and shorter investment periods and is more affordable by local farmers communities (de Foresta and Michon, 1993)[2].

3.3 ROLE IN LOCAL SOCIO-POLITICAL STRATEGIES

In many societies, planting of perennial species is commonly acknowledged by customary rule as conferring long-term use rights or ownership to individuals. In some places these rights are inheritable. Tree planting can be used as a strategy to establish or re-establish property rights over land. For example, the spectacular expansion of rubber, benzoin or damar plantation in Indonesian swiddens was partly driven by the need to establish stronger rights to forest lands (Dove 1994, Michon *et al.* 2000; see also papers in this volume by Dounias on cocoa planting under tree cover in Cameroon; by Michon, section on damar expansion; by Katz and Michon, on benzoin plantation, and by Aubertin on cardamom in Laos; see Box 6).

[2] Individual nurseries, in planting and transplanting tree seedlings on swidden fields, in managing intercropping phases, and in carrying-out selective clearing to sustain the growth of the commercial plants. The management of mature phases mainly involves relevant selection skills when managing the undergrowth, and above all enough anticipation to allow efficient and timely regeneration of the productive structures (Michon and de Foresta (1995)).

Box 6. NTFPs and the cycle of rice in Laos (by Catherine Aubertin)

Characteristically, key NTFPs in Laos are dependent on certain horticultural practices in the environment from which they are generated: the collection of such forest products is intimately connected with swidden cultivation and the cycle of upland paddy, culminating at some point during the dry season when either a rice gap must be bridged (between the previous harvest already consumed and the forthcoming harvest not yet in), or because only then is the time available for artisanal crafts and domestic maintenance (e.g., repairing thatched roofs and bamboo fences). Within this wide range of activities, some outputs may well be alternative subsistence foodstuffs, and/or marketable commodities to be sold or exchanged for rice. Broadly, these plants fall within two groups: the first, such as paper mulberry or benzoins, are those plants that grow spontaneously, with some assistance, in fields under slash-and-burn practices; while the second comprise species intentionally planted alongside upland rice to enrich the long fallow, enabling fallow fields to provide an economic yield throughout the entire period of soil regeneration, the best example being medicinal cardamom. In the rice fields, weeds and crop predators (e.g., rats and crabs) are themselves frequently eaten. Other edibles or marketables are collected along the paths connecting houses and fields, from the fallow fields, and from around the villages. The ecology and economics of such products cannot be separated from the farmers' agroecological systems and from forest production in general.

However, land is not the only target in this appropriation strategy. As in other domestication processes, ownership and control of the resource itself can be the main objective. When colonial or national policies, or even market organization, clearly favour external actors over local collectors of commercial forest resources, planting these resources in well-defined production systems can help maintain or re-establish control. Indeed, many examples of IS development in Indonesia were developed in response to a politically induced dispossession of native collectors (see for example Dove, 1994, on the transition from wild to *hevea* rubber in Indonesia). The pressure to plant might also come from a sudden increase in pressure on wild resources, which entails a quick deregulation of local control systems (see Michon *et al.* 2000 for the example of damar cultivation). It can also help capture more efficiently the benefits of their management[3] as in the case of rubber or dammar (Michon *et al.* 2000) or bamboo (Box 7).

[3] Among these benefits, local plantation often boosts local enterprises for harvesting, sorting, or semi-processing of the planted forest product, directly creating some additional value for local communities

Box 7: Selling bamboo shoots in Oudomxay: a successful case of participatory group building (by Joost Foppes)

In the village of Nam Pheng, Oudomxay, villagers used to be very poor, and could not produce enough rice to feed the community all year round. In the dry season they collected off-season bamboo shoots for sale, but the income was never enough. The IUCN/NTFP project assisted the villagers to analyze their problems (Soydara, 1999). In a series of meetings, the community gradually realized that they could improve their sales if they would all team up and sell for a fixed price, in a fixed place, not measured per bundle but measured per kilo. The community continued to discuss this idea until every family agreed to join the village selling group. The results exceeded all expectations. In five months, the village sold more 47 tons of shoots and earned 50 million kip or US$6,670 (on average 1 million or US$130 per family), at least four times more than the year before. The community also gained 5 million kip in a village development fund, setting aside 100 kip for every kilo sold. In the year 2000, the marketing group sold 44 tons, resulting in the equivalent of US$7,000 (1 US$ is about 7,500 kip). As a result, the community became very interested in monitoring and managing its bamboo forests. Together with district forestry officers, they are now conducting inventories of their bamboo forests and are testing various cutting regimes to determine optimal harvesting regimes.

The establishment of systems of forest plantation often creates new types of assets in traditional production systems. This might be an important incentive to plant trees or other forest plants in social contexts where land is the basis of family patrimony. In societies where production systems include both permanent and temporary elements (for example, irrigated rice fields, fruit tree gardens and swidden agriculture), there is often a clear social segregation between landlords (those who own the land developed for permanent agriculture) and the commoners (swiddeners who have no land of their own, and often no permanent housing in the village). Claiming the forest offers a way to acquire land rights on former swiddens, and this can change the social structure of the group, with swidden farmers joining the previously restricted category of landowners (Michon *et al.* 2000).

As the world looks for solutions to severe problems of poverty and environmental destruction, IS offer a way to combine the protection of forest functions and the expansion of economic opportunities through commercial tree crops. Under the current dominant model, governments in many tropical countries support large scale plantation of genetically improved varieties (of both forest and agriculture species). Commercial tree farming is usually done under the control of private or state corporations that physically and legally replace local farmers. There are many reasons for this preference, ranging from the ideological prejudices favouring "modern" production systems through to the obvious benefits of easier collection of revenues from producers who are fewer in number and who work at a larger scale. But this type of development clearly disadvantages local people who depend on forest resources, and leads to continued biodiversity loss. IS represent alternative strategies that, with appropriate research and development support, could reverse the process, and provide opportunities for rural people within a context of modernization and development.

3.4 ECOLOGICAL ROLE

Intermediate systems allow for the intensification of forest production while maintaining relatively high forest quality (biodiversity) and important forest functions like protecting against soil erosion, watershed management and carbon sequestration. Management increases production of particular species while restoring some of the original forest vegetation and providing habitat for forest fauna. Even in cyclic systems, where mass regeneration is used to rejuvenate the system, integrated management practices that respect natural processes in vegetation regeneration result in a relatively high level of recovery of the original forest biodiversity.

The resulting forest qualities and functions may be lower than in undisturbed ecosystems, but they are superior to current models of plantation forestry. [4] Although the main objective of IS is not to restore a forest, they nevertheless perform many restorative and regenerative functions. While forest cover is shrinking all over the tropical world, IS development could be a valuable complement to active forest conservation measures. Moreover, besides providing an original model for multipurpose forest development, they can help in reducing the ecological costs of natural forest conversion for intensive production.

IS represent good examples of the kind of small-scale, labor and energy efficient biologically-based systems championed by the "permaculture" school and others working on agricultural designs that stress ecological connections and closed energy and material loops (Diver 2001).

Biodiversity – productivity tradeoffs

There is often a trade-off between biodiversity (by some measure, often just a species count) and productivity (either total value of production per hectare, or profit per hectare) in resource management. A key proposition in the debate is that IS offer a compromise approach, with relatively high scores on both axes, and that the relationship is convex, as illustrated in Figure1.[5]

[4] In terms of forest ecological functions, specialised forest plantations can promote carbon sequestration or conservative water management. However, their role for soil conservation can be questioned and they do not participate much in biodiversity conservation.

[5] The curve might even have an increasing segment on the left side, as some disturbance (management) creates a more heterogeneous habitat that increases species diversity (e.g., gaps which invites colonising species).

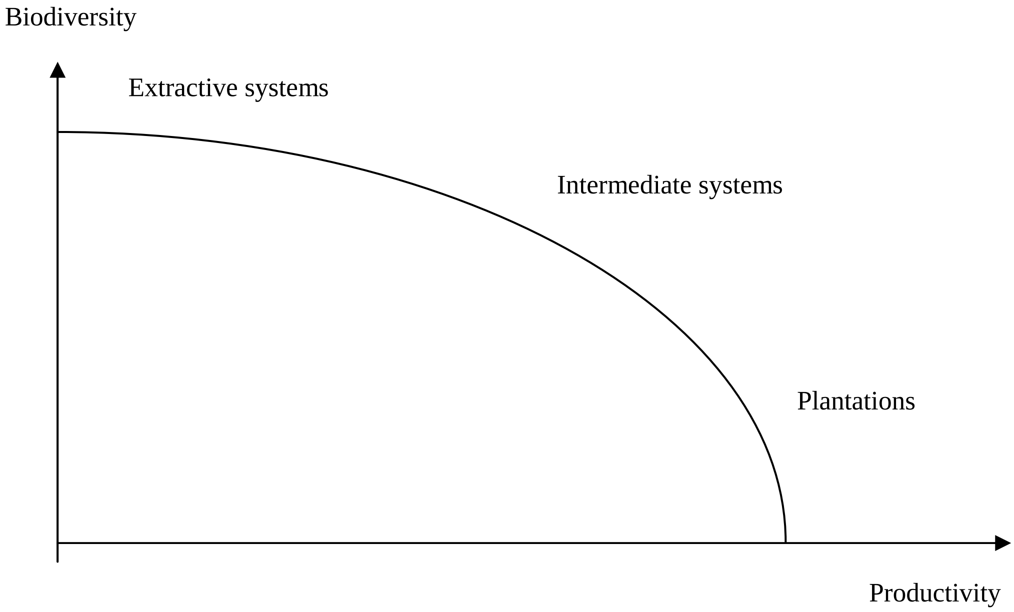

Figure 1: Hypothesized trade off between biodiversity and productivity.

There have been few systematic empirical investigations into this relationship, although van Noordwijk *et al.* (1997) corroborate the trends presented in the figure (see also García Fernández *et al.* 2002).

The role of IS as forest substitutes might be significant from an ecological point of view, especially in areas with high deforestation rates. In the eastern lowlands of Sumatra, where large tracts of *dipterocarp* forest have been converted to either forest plantations or non-forest use, the extensive area covered by native rubber gardens represents the largest local reservoir of plant and animal diversity (de Foresta 1993). In Southern Sumatra, damar agroforests surrounding the Bukit Barisan Selatan National Park constitute an effective extension of the natural forest and contributes to the conservation of wild mammals that need large territories, like rhinoceros, tapir, tiger and elephant (Michon *et al.* 2000). In southern Mexico, home gardens maintained by indigenous Mayan populations have served an important function in maintaining biodiversity (Box 8).

Box 8. The Mayan home gardens of Yucatan (by: Juan Malo)

The traditional home garden is one of the key elements for the self-sufficiency economy conducted by the Mayan peasants in the Yucatan Peninsula, and it determines the forested appereance of the villages in the region. They are land plots between 500-3,000 m^2 in which all the domestic facilities (e.g., hut, kitchen, latrine) are located, the domestic animals are grown, and where a variety of trees producing fruit, building materials or other goods are cultivated and/or tolerated. The tree cover of home gardens gets established through a combination of keeping species previously existent in the wild vegetation, tree planting, and by the establishment from seeds dispersed from the surroundings. All this, together with the watering and management of vegetation, leads to the high species diversity of home gardens, and to their appearance of medium or tall rainforest in sharp contrast with the vegetation surrounding the villages. Among the tree species found in the home gardens, there is a noticeable number of species from tall-evergreen and medium rainforests typical from the most humid areas in Yucatan, as well as a high diversity of non-commercial cultivars. The Mayan villages thus have a relatively high natural value from the agronomic as well as from the naturalistic point of view, since they act as refugees for cultivars almost disappeared and for species now scarce in the wild. At present, the home gardens are maintained in most villages in Yucatan devoted to the provision of goods for the Mayan families, with a minimum tendency towards the specialization of production for commercialization or to the abandonment as a result of changes in the economic activity of peasants.

3.5 ROLE AT NATIONAL LEVEL: CONTRIBUTION TO NATIONAL DEVELOPMENT

Many intermediate systems make significant contributions at the national level, especially in terms of foreign exchange earnings. This contribution is often concealed in national statistics as part of larger categories such as “tree products”, or “NTFPs” that may include production from industrial estates, horticultural crops or extractivism. For example, 60% to 70% of the rubber latex exported from Indonesia is produced by smallholders in “jungle rubber” gardens (see Joshi, this volume). A significant proportion of the spice crops (clove, nutmeg, cinnamon) in Indonesia also derive from such systems. In Cameroon, a large part of the exported cocoa is produced in agroforests, not in pure plantations (see Dounias, this volume; see Box 9). In Indonesia, most of the fruits entering inter-island trade and sold on local markets, are produced in various types of fruit agroforests, forest-gardens or highly diverse home-gardens. In Indonesia again, many of the most important NTFP are produced in intermediate systems, not in natural forests. This includes 100% of the dipterocarp damar resin of the clear type (8000 to 12000 tons per year, Michon *et al.* 2000)), all the benzoin exported from Sumatra, and a large proportion of small-diameter rattans.

Box 9. Cocoa plantations of southern Cameroon (by: Edmond Dounias)

Cocoa plantations of southern Cameroon are very old and their yield is low. Most of the plantations were created during the 1920's and 1930's. They are permanently rejuvenated by planting juveniles to replace old and unproductive plants or in gaps caused by dead trees. Average size of plantations is around two hectares and the basic production unit is the household. Cocoa plantations are generally established in mature swidden fields. Seedlings are transplanted into swidden parcels and grow among the post-agricultural regrowth. Cocoa trees have always been and still are associated with dominant trees that have diverse origins. Some are remnants of the pristine forest and were maintained during the creation of the swidden, some are light-demanding species that established during the fallow period, and some others were voluntarily transplanted or even introduced into the parcel. Most of these trees – a mixture of native and exotic species - provide NTFPs. The original shading function of the dominant trees is no longer justified, now that improved cocoa cultivars are "selfshading". Agricultural policies that aim at encouraging the intensification of cocoa production push for a systematic elimination of shade trees, because excessive shade encourages fungal attacks that drastically affect production of improved cultivars. Farmers are reluctant to eliminate these trees and prefer to maintain older cocoa varieties which are more resistant to fungal pathogens. Farmers express their preference for an optimized intermediate system (justified by socio-economic choices and land tenure strategies) rather than a maximized yield of a monospecific and cash-crop plantation.

4 LONG-TERM DEVELOPMENT TRENDS AND THE KEY DRIVING FORCES IN THE EMERGENCE AND EVOLUTION OF IS:

The discussion about benefits raises some important questions. If these systems are so beneficial, why are they not more common or widespread? Are they in fact competitive with other systems? Are they sustainable (economically, ecologically, socially) or are they actually gradually disappearing? Most theories of agricultural development hold that there is a systematic evolution from hunting and gathering in natural forest to agriculture and domestication in intensively managed systems, with IS representing a transitional phase. Is this correct? Or do these systems represent robust and stable alternatives to more intensive management systems? What conditions govern their sustainability or their transition to other management approaches?

We explore these questions in several parts. We distinguish between three processes related to IS development: evolution (emergence), intensification, and breakdown. We should stress that the sequencing of these three processes does not necessarily imply a linear process from one to the other. Different disciplines and schools of thought necessarily focus on different aspects and drivers of these processes. We highlight technical, ecological, economic and socio-political drivers. The key driving forces for the three processes are summarized in Table 1. There are strong similarities among the drivers of all three processes; increased land scarcity, for example, is a key driver for all of them.

Drivers	Evolution	Intensification	Breakdown
Land scarcity (pop. density)	***	***	***
Market access – price	*	***	*
Labour costs	**	**	***
Infrastructure	**	***	**
Tenure – resource control	***	**	**
Political recognition of IS	*	*	***
Synthetic substitutes			***
Suitability for mono-cultivation			***
Access to appropriate technologies		*	***

*** indicate level of importance of the particular variable.

Table 1. Key drivers in the evolution, intensification and breakdown of intermediate systems.

4.1 HOW AND WHY DO IS EMERGE?

Intermediate systems are organized to produce one or more traded commodities. Any discussion of the development and evolution of IS needs to consider economic factors such as market demand, the economic organization of commercial exchanges, the availability and productivity of production factors (land, labour, capital in the form of cash or credit), the household's socio-economic strategies (e.g., management of risk and wealth accumulation), and the compatibility of the system with other activities. Factors related to the social organization of the production (in particular those related to land tenure and power relations) and the political background of this production should be integrated as well. All these variables combine in various ways to influence the evolution of a system.

Homma (1992) developed a simple supply and demand model of the development of cultivated production of NTFP (Figure 2). The model begins with a system in which a product has some trade value and is available wild in the forest. During the first phase production expands as collectors harvest increasing quantities from available natural supplies to meet market demand. This continues until an equilibrium is reached between supply and demand. During this phase, which Homma called the stabilisation phase, some farmers begin to experiment with management and cultivation of the product, and a proportion of the supply is met from cultivated sources. If demand exceeds the sustainable supply from the wild resource, overexploitation will result, wild supplies will decline and - as long as demand remains high - prices can be expected to rise. This creates an incentive for expanded cultivated production, and cultivated supplies soon take over the market.

The model assumes that the development of markets (including demand for the product, a reasonable price relative to the costs of production, and organization and infrastructure requirements for the exchange) creates the stimulus for people to begin to manage/cultivate the product. Indeed, each of the examples referred to in this volume developed in response to a market for a given forest product. Aubertin (this volume) offers an example of a newly developed IS, for Cardamom production in Laos. Here, sustained demand and declining wild resources led people to begin cultivating the plant. In each case the cultivation system represents an evolutionary and not a revolutionary step. Farmers were able to incorporate a familiar product, at relatively low cost and low risk, into their existing farming system.

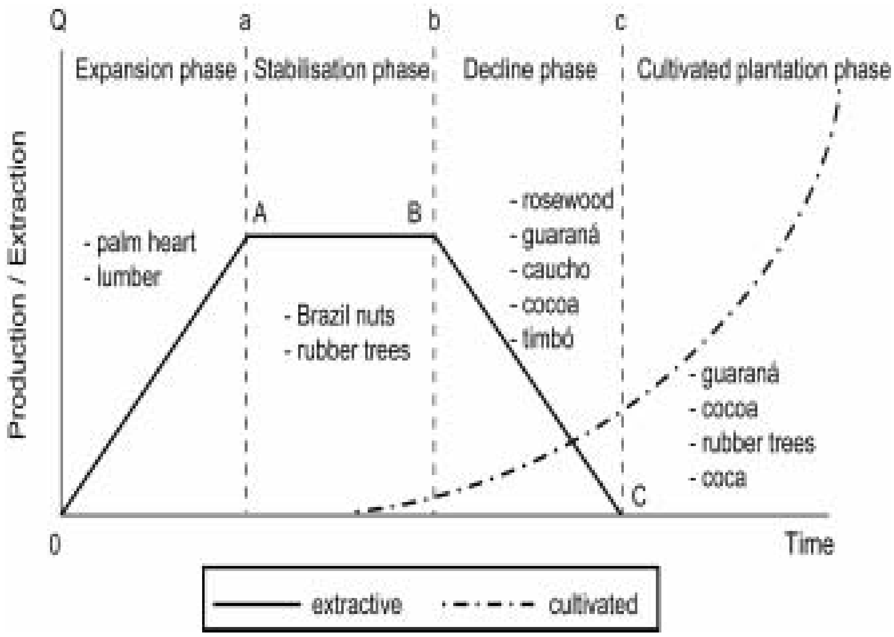

Figure 2. Homma's model of phases of forest product extraction and cultivation.

There are other conditions that are not explicit in Homma's model that facilitate or encourage the development of an IS. The earlier discussion has highlighted several. Property rights are important in the establishment, maintenance or collapse of IS. In the example of damar cultivation, the large-scale adoption of damar as a promising crop was stimulated by a switch in customary systems from collective land property on forest lands to the acknowledgement of land rights to the individual planter and his heirs (see Michon this volume). In most examples cited in the workshop, one of the minimum conditions required for the success of the IS is some level of tenure security.

However, IS management can also be a tool in establishing and maintaining tenure control. In many traditional tenure systems, tree planting is recognized as a mark of “ownership”, and states also sometimes recognize claims based on planted perennial crops. Whereas an abandoned fallow field may be subject to appropriation by another party, a rattan or benzoin garden, for example, is understood to belong to the person who planted it or to his family. The establishment of such a garden is a relatively low-cost mechanism of securing land tenure, and can be used as a strategy for land appropriation. Planting may be triggered by an actual or perceived change in tenure status. In situations where traditional forms of local control and ownership are questioned by external actors, or are being re-evaluated locally, local people may adopt intermediate management systems as a way to establish and demonstrate ownership. As an example, the expansion of benzoin gardens in the highland forest of North Sumatra, at a time where market prospects for the product were not bright, represents a local strategy of re-appropriation of customary lands, formerly seized by colonial forestry services for conservation purposes, in the post-independence context (see Michon, this volume). Likewise, many rubber trees throughout Indonesia have been integrated in fallow lands not just for production purposes, but also to support claims for compensation in case of forced dispossession. These attempts are made notwithstanding that in past land disputes between local farmers and private plantation firms in Indonesia, IS have rarely been recognized as a proof of land ownership deserving compensation.

4.2 INTENSIFICATION OF IS

Once established, IS can be maintained over the long term, abandoned, or intensified. The Homma model suggest that there is an evolutionary path, driven by economic forces, that leads from low to high levels of management intensity. In this model, IS would be intermediate along a development path toward intensive management.

This proposition is congruent with the Boserup (1965) theory that higher population densities (often equated with increased land scarcity) lead to more intensive use of the scarce resource, namely land. It implies that intermediate management systems will not be the best use of land as development proceeds and that IS will be replaced by more intensive management (higher levels of labour and capital inputs per unit of land) and higher land productivity. If this is true, farmers/land managers will abandon IS in favour of more intensive systems producing high-value commodities as land becomes relatively more valuable.

Increased market access and higher demand from outside encourages more intensive production of higher value products. As people become more integrated in the cash economy they tend to focus on producing commodities that have the highest cash value. Within a subsistence economy, people produce and use a number of goods (forest and agricultural products) that can be replaced or made less useful (or less desirable) by new products and pressures (such as advertising) from outside. Producers shift their effort from these products and intensify their production of more valuable goods.

This type of intensification does not necessarily imply the abandonment of all the products and functions of the system in favour of a single product. Intensification may occur through the diversification of production, which raises the overall profitability of the system without substantially changing its structure. For example, in the 1980s, the fruit gardens in West Java have "specialized" in a highly diversified fruit production for urban markets, using improved fruit varieties and some adjustment in the garden structure, while maintaining a mixed-species forest-like strucutre (Michon & Mary, 1990). Similarly, the damar agroforests have gradually integrated intensive production of two varieties of highly valued fruits without fundamentally changing their structure or overall management (Michon *et al.* 2000).

However, economies of scale in trade and marketing encourage specialization and intensification and expansion of production of the most rewarding products (Belcher, Ruiz-Perez and Achdiawan, 2003). This has happened in Thailand when traditional fruit gardens gave place to intensive fruit cropping for urban and international markets.

The appropriateness of any management system is influenced by a set of ecological and technical factors, including the level of natural resource availability, patterns of resource dynamics, productivity limits, competition, and the technology available. IS have, by definition, relatively low input requirements. Most such systems have developed as part of traditional systems, and are well adapted to low natural fertility/productivity. However, as people obtain access to modern technologies, including fertilizers, mechanical clearing devices (e.g. chainsaws), mechanical harvesting equipment, and improved transportation, they are better positioned to adopt a more intensive, higher-throughput model.

More intensive use of the land, which requires a higher level of investment (of labour and/or capital) may be undesirable if there is a risk of losing the land or the products of the investment. Land tenure is important here, as it was in considering how IS develop in the first place. Whereas the development of IS needs a minimum level of tenure security, increased tenure security over land, coupled with higher land values, is likely to drive intensified land-use. Secure land tenure favours more intensive management systems. At the same time, tenure security is not something fixed but is influenced by decisions taken by the land manager. Intensification is often a way to increase the claim of the land and the recognition by both local and outside land users as well as the state. Thus there is a two way relationship between the tenure security and intensification. Insecure tenure can, in fact, promote intensification if that leads to more enforceable claims over the resources (Otsuka and Place 2001).

Global forest regulations and agricultural policies are also major drivers towards intensification of IS (as they are towards their abandonment). There are many examples of direct correlation between agricultural or forest policies and intensification: in smallholder rubber production in Indonesia, national policies which actively supported (through credit facilities) the use of using cloned plant material and fertilizers led smallholder rubber growers to turn from "jungle rubber" to intensive and specialized rubber production. More often, however, the way policies affect intensification is more indirect. This can happen through extension programmes, where extension agents criticize, or ignore, traditional forms of tree management. In West Sumatra for example, extension agents provided insecticides for nutmeg production if and only if nutmeg trees were grown in well-ordered orchards, not in the native diversified fruit gardens (Michon *et al.* 1986). This can also happen when forest conversion policies consistently refuse to acknowledge local systems of forest management and the related customary systems of resource control. Many rattan gardens in East Kalimantan have been affected by conversion policies which transferred large tracts of "degraded forest" – including well-established and productive rattan gardens - to oil palm or fast-growing tree plantation companies.

4.3 ABANDONMENT OF IS

We also need to consider the conditions that lead to abandoning IS (as opposed to intensifying). Some are just the inverse of the conditions that lead to establishment and intensification. For example, if demand (value) of the main commercial product produced by a given IS decreases, farmers might abandon the system if there are viable alternatives (as happened in the rattan case, Belcher *et al.* this volume).

In many of the existing IS there are only one or few marketable outputs. Increased involvement in the cash economy increases the value of labour. When people have an opportunity to sell their labour they will be less inclined to engage in low value pursuits, or in activities that do not occupy them fully. While IS have relatively high returns to labour compared to other opportunities in a traditional context, it is quite possible that they will be out-competed by new opportunities arising in a cash economy context.

A contrary hypothesis is that, because IS production is less labour demanding, and often the timing of labour requirements is less critical than for agricultural activities, it may be possible to blend IS activities with wage-labour activities, filling in seasonal periods with low conventional agriculture (or off-farm) labour demand. For example, in the villages surrounding the city of Bogor in West Java, most former rice farmers have engaged in part-time urban business, but they have kept their fruit gardens as a complement of their main economic urban activity (Michon & Mary 1990).

Another economic issue that is important in determining the role of IS is risk and strategies for risk management. Households managing such systems typically produce several or many products from agricultural fields, from forest collecting, and from the forest garden itself. This strategy ensures a flow of benefits over the year and provides insurance against the risk of failure of a product or a drastic price decline. But the importance of traditional social security or insurance systems - in the form of a reserve of forest products, or social norms for sharing - tends to decline as modern insurance systems (e.g. bank savings, secure employment, and commercial insurance) develop. Thus, communities at some "intermediate" stages in this social development process might lack both the traditional and modern insurance systems and will be particularly vulnerable to shocks and crisis. If this is true, and if IS are transitional, we might conclude that IS are particularly important (or well suited) for societies at some "intermediate" level of "development".

This hypothesis could be tested by observing the evolution of IS both in conditions of *reduced* risk/alternative risk management strategies, where one would expect to see a decline in the importance of IS and diversification strategies generally, and in conditions of *increased* risk/reduced reliability of alternate risk management strategies, where one would expect to see increased importance of IS. Good examples of the latter situation are to be seen in parts of Africa, where the costs of intensification are increasing and risk is increasing and there is a tendency to revert to less intensive/more diversified production strategies (see Dounias, this volume)

Technological improvement also leads to the production of industrial substitutes for natural products. Many once-commercially important natural products have been completely or partially replaced by chemical substitutes, including rubbers and other natural latex (*getta percha, chickle, jelutung*), oleo-resins, gums, flavouring agents like vanilla and cinnamon, and essences like sandalwood and rosewood.

Substitution has led to the collapse of many extractive systems. However, while extractive rubber production in Brazil collapsed, smallholder rubber production in Indonesia has consistently increased over the last century. Similarly, where the replacement of damar by industrial resins led to the collapse of wild damar collection in Kalimantan and the abandonment some damar agroforests in South Sumatra, damar agroforests in the area of Krui have consistently expanded until today. The hypothesis might be that IS are more resilient than extractive systems. Managers have more invested and, with more concentrated production and more control over that production (technically and in terms of property rights), they are in a better position to pursue and exploit particular market niches. Moreover, as discussed above, IS provide other non-financial benefits (see also Belcher et al (in press)).

Another issue, raised in several of the cases presented at the meeting, is that there is a lack of official acknowledgement (either legal or technical) of IS. Development plans, policies and regulations tend to favour more intensive land management systems and implicitly or explicitly lead to the weakening or disappearance (if not deliberate replacement through government development plans) of intermediate systems. Crop improvement research has focused on producing sun-tolerant varieties of crops best suited to cultivation in specialized fields, without shade trees. Many farmers have therefore abandoned traditional mixed-systems. IS have not benefited from the technological improvements developed for agriculture or forestry, and have not been supported by extension or other policy instruments.

This lack of recognition of IS by dominant groups in political, science and development arenas, relates to issues of global perceptions of the relation between society and nature, and to the representation of what “development” means and should look like. Perceptions of development and modernity have an important influence on whether or not “intermediate” systems are maintained. We have shown how the western perception of the superiority of grain culture over horticulture has impacted on the development of native forms of forest resource management in the tropics, including IS (for a full development on these issues, see Conklin 1957, Geertz 1966, Haudricourt 1943, Barrau 1967). This dominant perception of a “natural” agricultural development has led to lack of official acknowledgement of indigenous practices –and rights- over forest resources. Indigenous practices for forest resource and agricultural development (including slash and burn and IS) are commonly regarded as “primitive” if not as a threat to the environment (ASB), and the multiple values of such systems are often not recognized. Government efforts often aim to modernize the resource management methods used by local people and move toward more intensive system.

The perceptions of the managers themselves are, of course, important. As intensive systems of forest management or agriculture are typically regarded as being more modern and local systems as “bush work”, local people are inclined to abandon traditional approaches. On the other hand, with new attention to the need for ecologically sound practices for environmental management, intermediate management systems can appear as “green” and be promoted for their technical value. In many of the IS illustrated in this volume, the perception of the systems by the managers themselves has completely changed over the last 10 to 15 years, starting from a feeling of shame for their “primitiveness” to one of pride in their environmental stewardship. This emphasis on the ecologically sound management in IS often serves more socio-political than conservation or sustainable development objectives.

5 CONCLUSIONS

To understand the role of IS in the rural economy and assess its comparative advantages, one needs to consider how these system are integrated into the overall household economy and livelihood strategy, their importance in the landscape and in surrounding natural systems, as well as their role in social relations and in political strategies. IS offer diversified income-earning opportunities, with cash income from the main product and as well as producing other cash and subsistence products (foods, fuel, building materials, medicines) from the same area. They provide safety nets as sources of food, cash and medicine during times of need. Many IS serve as means of saving, with a reserve of capital to be drawn from when needed. IS tend to have relatively low labour demands, timing of labour inputs is flexible, and the return to labour is high. These systems fit well in economies in which labour is the limiting factor. And they also fit well as part of an overall land use system, complementing other land uses in *time* (as part of a rotational system, for example), and in *space* (where the location of the farmers forest is determined by the distance to the settlement and the quality of the land). They have important ecological functions (biodiversity, water regulation, carbon storage). They shape and support social relationships. They are an important element in the power relations between local farmers and dominant groups regarding land tenure conflicts and forest development.

But these characteristics of IS only offer advantages under certain circumstances. The important questions are where and under what conditions are IS competitive with alternative landuse systems? Product demand is a key factor, determining the income generation potential and the overall profitability of the system. This was one of the strongest conclusions from the Lofoten workshop: the market for the product, shaping the price level and fluctuations, is a key for the viability of the system. Both rattan and benzoin are examples of systems that have suffered from stagnating markets. Nevertheless, there is an important inertia in IS *vis à vis* market fluctuations: contrary to systems based on short-cycle crops, IS are not immediately abandoned when the market of the main product stagnates or shrinks. They may rebound through the introduction of alternative products (rubber versus benzoin, see above), be maintained in dormancy for many years in expectation of a market rise (this often happened in jungle rubber as rubber market dropped), or maintained for non economic (mainly social or political) reasons (see the examples of damar and benzoin, Michon this volume).

The opportunity costs of labour and land are also important for the evolution of the system The widely held perception that forest extractivism is mainly an activity for the poor reflects their lack of opportunities (low opportunity costs of labour). The dependence on NTFPs other than rubber in the forest in Riau has declined significantly over the last decade, reflecting better income opportunities in other activities. Rubber produced in rubber-based IS remains as one of the more important NTFPs. providing a relatively remunerative and secure income for a large share of the population.

The economic literature suggests that higher land scarcity (or population density) is a major driver towards more intensive land use in a process that moves from extractivism to intensively managed (monoculture) systems. Generally, this phenomenon was *not* observed in the study sites considered at this workshop. The few sites where extractivism appeared to lead to more intensively managed systems, this pattern was primarily interpreted as being a result of (or driven by) large-scale conversion of land use systems due to externally-supported projects (oil palm or transmigration). The cases presented at the meeting indicate that changing output prices, better opportunities, and political factors have been more important than land scarcity *per se* for the development of these systems over the past one to two decades. Although land scarcity may be an important factor in their decline, it did not appear to be a prevalent driving force in the selected IS cases presented at the meeting. A broader comparison of NTFP commercialization patterns (Ruiz-Perez et al, forthcoming) shows that IS are found in relatively remote areas with low population densities, limited transportation infrastructure and relatively low land prices.

Finally, global as well as national policies are essential to the present and future development of IS. Present forest and agricultural policies, as well as broader economic and land titling policies, preferentially support one particular type of development and particular stakeholders to the disadvantage of IS models and their smallholder managers. Intensive agriculture/forestry has developed not only because it was economically profitable, but also because it was politically desirable and supported through an artillery of policies and regulations. Smallholder forms of resource management are rarely supported by governments; on the contrary, policies have contributed indirectly or directly to their stagnation or collapse. The recent emphasis on sustainable development and poverty alleviation (cf. the conclusions of the World Summit in Johannesburg, August 2002) combined with long-standing recommendations and conventions on environmental protection (see the Rio Conference, 1992) gives room for more recognition and promotion of IS throughout the tropics.

6 POLICY AND RESEARCH IMPLICATIONS

IS do have a role under the conditions identified above. Moreover, there is evidence that such systems have been overlooked and even discriminated against. Thus, there is potential for both improved local livelihoods and better forest management through further research and development in the area.

As a first step, there is a need both among researchers, policy makers and planners, and the development community in general to recognize the importance of IS to current users.
It is critical to consider whole systems and not view IS in isolation. In many forest-based livelihood systems (not just IS), people rely on a high diversity of forest products, and the actual mix changes seasonally and annually depending on the opportunities available. Interventions should protect (and not compromise) flexibility.

It is common in IS that legal property rights recognition is weak, even if local institutions recognize the rights of managers. Legal support can improve security and thereby provide incentives for improved management and investments.

IS have benefited little from scientific research. There is good scope for improvement through improved silviculture and management, and also through selection and breeding of improved varieties suitable for cultivation in mixed systems.

Important constraints often occur downstream in the processing and marketing chain. Typically, small-scale forest product producers are disadvantaged by weak transportation infrastructure and opaque markets. Producers that are actively managing production in IS may be further disadvantaged by government regulations that were designed to deal with wild harvested products, with unfair restrictions and fees. Identifying and reducing these constraints should be a priority.

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